



A Comparison of Contrast Sensitivity and Sweep Visual Evoked Potential (sVEP) Acuity Estimates in Normal Humans.

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Introduction

- Previous studies have compared contrast sensitivity and acuity estimates from the sVEP and psychophysically determined CSF with research based equipment.¹⁻⁴
 - Good correlation (r of 0.81 – 0.91).
- Results depend on equipment and methods employed.
- Commercial contrast sensitivity and sVEP systems currently available.

Introduction

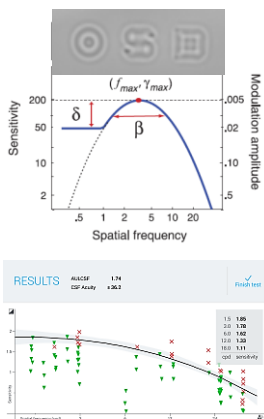
- The purpose of this study was to determine the relationship between acuities extrapolated from contrast sensitivity functions (qCSF and Beethoven systems) and the sweep visual evoked potential (PowerDiva) using commercially available equipment.

Methods - Subjects

Subject	Sex/Eye	Age (years)	Correction	Snellen	VA (cpd)	qCSF (cpd)	Beethoven (cpd)	sVEP (cpd)
1	F/OD	26	Plano DS	20/15	40	23.4	21.6	29.8
2	F/OS	26	-3.00 -1.25 X 130	20/15	40	27.1	21.3	29.2
3	F/OD	24	-5.50 -0.25 X 180	20/20	30	18.8	18.0	27.7
4	F/OD	24	-2.50 DS	20/15	40	35.9	41.4	32.1
5	F/OD	27	-1.75 DS	20/15	40	32.7	31.4	27.7
6	F/OD	25	Plano DS	20/15	40	26.1	25.2	28.1
7	M/OD	23	-0.50 DS	20/15	40	38.1	32.4	37.9
8	F/OD	25	-4.00 DS	20/15	40	29.1	34.9	41.0
9	F/OS	21	-1.50 DS	20/20	30	23.2	22.2	30.3
10	F/OD	22	Plano DS	20/20	30	21.3	25.0	28.3
Average		24.3			37.0	27.6	27.3	31.2
SD		1.89			4.83	6.36	7.38	4.59

Contrast Sensitivity

- Two Instruments:
 - Beethoven system (Ryklin Software, Inc., NY).
 - Quick CSF system (Adaptive Sensory Technology, Inc., CA).



Quick CSF (qCSF)

The spatial CSF can be described by four parameters: (1) the peak gain, γ_{max} ; (2) the peak frequency, f_{max} ; (3) the bandwidth (full-width at half-maximum), β ; and (4) the truncation (plateau) on the low-frequency side, δ . The qCSF method estimates the spatial CSF by using Bayesian adaptive inference to directly estimate these four parameters.

Data returned: VA, area under the curve, and CS at 1.5, 3, 6, 12, and 18.5 cpd.

Lesmes, et al. JOV 2010, 10:1-21.

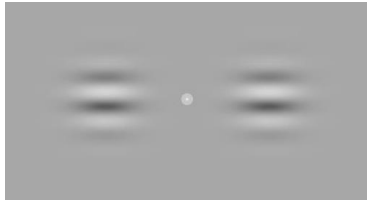
Beethoven Contrast Sensitivity

- A horizontally oriented sine wave grating was viewed from 200 cm on a ViewPixx monitor set at a mean luminance of 100 cd/m².
- The grating was produced with the Beethoven software (Version 754).



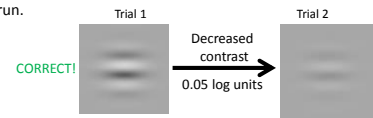
Beethoven Contrast Sensitivity

- The stimulus had a diameter of 5 deg and was overlaid with a gaussian profile (Gabor patch).
- Presented on the left or right of the screen (2AFC) for 1500 ms.



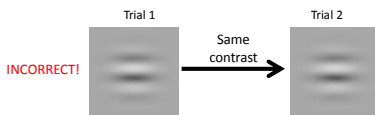
Beethoven Contrast Sensitivity

- Trial Procedure:
 - Auditory tone on (trial cue); Fixation spot on: 1000 ms.
 - Fixation spot off; Stimulus on: 1500 ms.
 - Auditory tone off; Subject responds (left/right): 2000 ms.
 - Subject responds by pushing joystick left or right.
 - Correct choice:
 - Contrast of the grating decreases by 0.05 log units and the next trial is run.



Beethoven Contrast Sensitivity

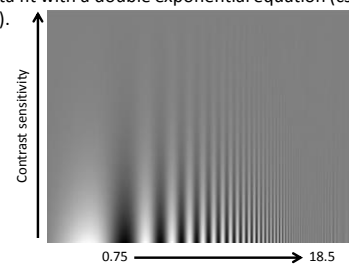
- Incorrect choice: Trial repeats at the same contrast.



- Two consecutive incorrect choices:
 - Current contrast taken as *threshold*.
 - Contrast increased 0.3 log units and the process begins again.
 - Minimum of two thresholds per spatial frequency obtained.

Beethoven Contrast Sensitivity

- Contrast sensitivity was determined at 8 spatial frequencies: 0.75, 1.5, 3.0, 6.0, 9.0, 12.0, 15.0, 18.5 cpd.
- Data fit with a double exponential equation ($cs = k_s(ws)^{\alpha}e^{-\beta ws}$).



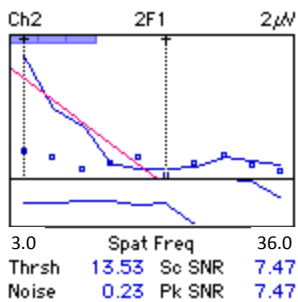
sVEP Methods

- PowerDiva version 3.5.
- Stimulus is a horizontal sine wave grating (80% contrast, 7.5 Hz).
- Monitor (100 cd/m²) viewed at 3 m, screen 7° X 6.06°.
- 10 spatial frequencies from 3 – 36 cpd.
- 10 sweeps averaged together for one acuity estimate.
- 2 acuities averaged for final acuity.

sVEP Methods

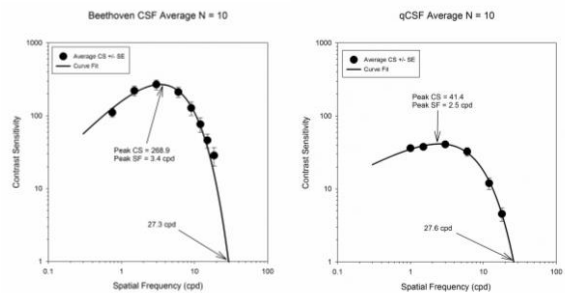
- Silver/silver chloride active electrode placed 2 cm aboveinion.
- Ground and reference electrodes placed on ear lobes.

PowerDiva Sweep VEP

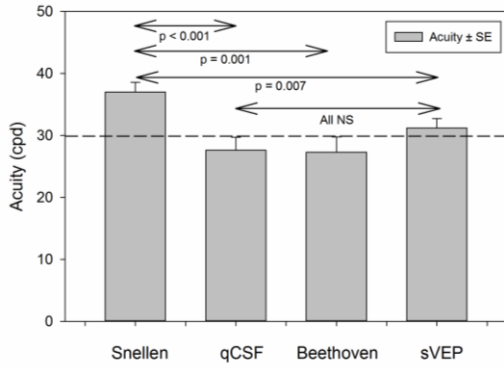


1. Acuity determined by fitting a line from the function peak to highest spatial frequency above noise.
2. At least one spatial frequency needed a SNR > 3.0.
3. Individual spatial frequency data are considered to be noise if SNR 1 or less.
4. T_{circ} statistic < 0.05.
5. Acuity extrapolated to 0 μ V.

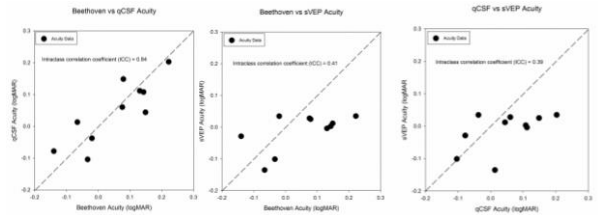
Results – CSF



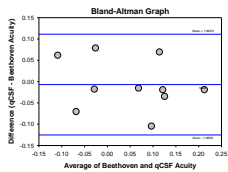
Average Acuties



Intraclass Correlation Coefficients (ICC)



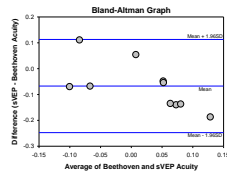
Bland-Altman Plots (logMAR)



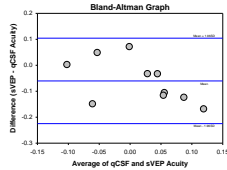
Bias ±
LOA = -
0.07 ±
0.21

Bias ± LOA =
-0.007 ± 0.12

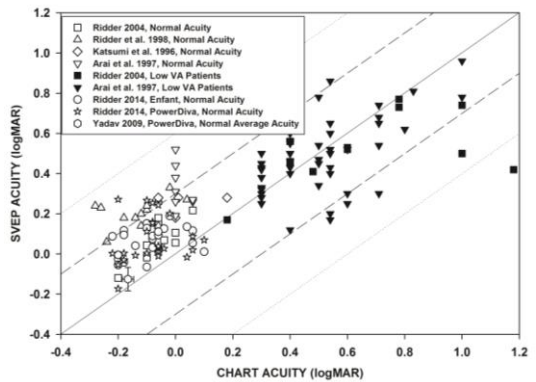
Arditi, et al. 1993 IOVS,
0.14 logMAR for ETDRS
charts



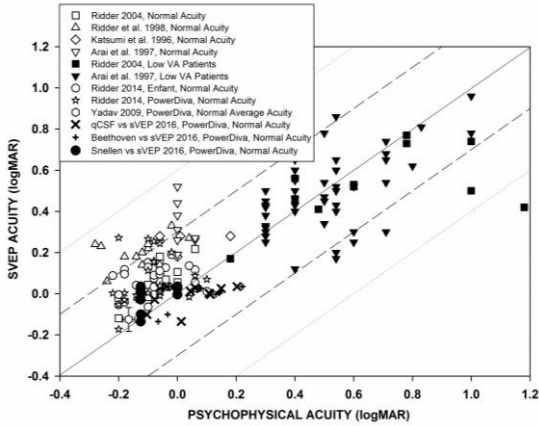
Bias ±
LOA = -
0.06 ±
0.19



SUMMARY



Ridder, et al. 2014 Doc. Ophthalmol. 129:105-114.



Conclusions

- There is not a statistical or clinically significant difference between the CSF and sVEP estimates of acuity.
- All three estimates of acuity were statistically different from the Snellen acuity. However, this may not be clinically significant.
- The ICCs and the LOA were best for the acuities extrapolated from the qCSF and Beethoven.

References

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